SWEET CLOVER

RESULTS OF EXPERIMENTS
at the
DOMINION EXPERIMENTAL FARM
Brandon, Manitoba

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SWEET CLOVER IN MANITOBA

The popularity of sweet clover as a farm crop for Manitoba has become well established. According to the report of the Manitoba Department of Agriculture, there were 198,841 acres of this crop under cultivation in the province in 1929. This figure represents over 46 per cent of all the grasses and clovers grown for hay and pasture, exclusive of native prairie grasses. The following figures represent the Manitoba acreages of the more commonly grown hay crops in 1929 as compared with sweet clover:—

Western rye grass	16,248 acres
Brome grass	108,471 "
Timothy	88,251 "
Alfalfa	11,229 "
Sweet clover	198,841 "
Other clovers	9,167 "

The ability of this legume to thrive under diverse conditions of soil and climate, and the value of the crop for soil improvement, for pasture and for hay, have all contributed towards its popularity. There has always been, however, a certain prejudice against sweet clover on account of its coarse, woody stems, its aggressiveness in waste places, and its bitter taste.

The repeated demand for information regarding the culture of this crop in this province has prompted the preparation of this pamphlet. It is proposed to present the results of the experiments at the Dominion Experimental Farm, Brandon, and to discuss other points in connection with this crop.

SOIL REQUIREMENTS

Sweet clover, like most other cultivated plants, thrives best on good, well-drained and well-prepared soils. It grows, however, on almost any soil, and for this reason, it is possible to make the poorer fields on the farm give reasonable returns. The ability of this plant to thrive on poor soil is due mainly to the rapid growth of its extensive root system, and to the fact that it is able to draw upon the air for its nitrogen requirement.

The environmental conditions which seem detrimental to the proper development of sweet clover are two: lack of lime, and poor drainage. The plant will, however, withstand poor drainage conditions better than most other legumes. It is also claimed by some that this crop is partially resistant to concentrations of salts and to soil alkalinity.

Probably one of the most valuable qualities of sweet clover is its ability to improve soils. Being a legume, it has the ability to extract free nitrogen from the air and incorporate it into its tissues. Through the practice of continuous grain growing much of the soil in Manitoba has become deficient in organic matter and has a lowered water-holding capacity. It is generally recognized that the sweet clover crop through the decay of its extensive root system will add to the organic content of the soils on which it is grown.

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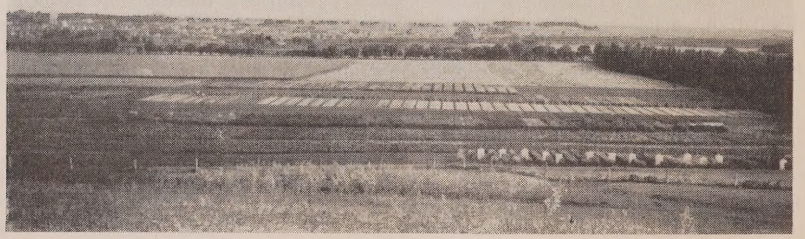
UTILIZATION

Hay

There has always been some diversity of opinion with regard to the value of sweet clover for hay, and while it is generally considered to be quite palatable and nutritious if cured at the proper stage, it is safe to say that it is more difficult to cure and less palatable than alfalfa. The leaves dry up much more quickly than the stems, with the result that by the time the crop is dry and ready for storage, a large proportion of the leaves will have been shattered through handling. Since the spring growth is very rapid, the first cutting is usually ready before the weather has become settled, and proper curing is therefore made more uncertain. When grown on very rich soil, the growth is likely to be rank and coarse, the plants often reaching a height of two to four feet even before the buds appear. Hay made of this coarse material will cure with difficulty.



General view of the forage crop plots at the Brandon Experimental Farm.

The bitter flavour in the leaves of sweet clover, due to its coumarin content, is objectionable, but not sufficiently so to interfere to any great extent with its feeding qualities. A considerable quantity of this coumarin is liberated during the process of curing. While some animals do not relish sweet clover hay at first, feeding trials have demonstrated that cattle acquire an appetite for this hay, provided it is not too coarse and has the bright green colour indicative of good curing. At this Farm, it is interesting to point out, that sheep, having access to coarse sweet clover hay harvested in sheaves, as well as corn silage, have shown a decided preference for the clover, and continued in excellent condition throughout the winter. They did not eat the coarsest stems.

During recent years work horses have been fed sweet clover hay. The plan followed has been to run the hay through the cutting box and to moisten each day's feed with water and mix the meal with the cut hay. The teamsters on the Experimental Farm are of the opinion that the horses thrive much better on the sweet clover hay than they do when fed the grass hays. When handled in this way, there is very little wastage from even fairly coarse sweet clover.

Pasture

With few exceptions, sweet clover seems to have given excellent results as a pasture crop. On the Experimental Farm at Brandon, while no definite feeding trials have been made, cattle have been pastured on this crop with no apparent ill effects. The milk supply was completely maintained and no complaints were received reporting the odour or flavour of the milk as being disagreeable. The condition of the animals was not in any way affected. Other reports from different parts of the province have been equally favourable.

Occasionally reports have been received of cattle bloating on sweet clover pasture. It has been noticed that these reports usually come from farms with heavy soil. There is also an impression abroad that bloating more often occurs where the yellow blossom sweet clover is grown than where the white blossom is used. If this is a fact the difficulty might be due to the more decumbent habits of growth of the yellow blossom. It is quite possible that this type of clover may hold more moisture from the dews and rains and does not dry off as quickly as the more upright growing white blossom types. It may also be expected that there will be ranker and more succulent growth of clover on the heavy lands and this too may result in slower drying following heavy dews or rains.

The young cattle and dry cows from the Experimental Farm herd have been on a mixed pasture of sweet clover and grass during the last five summers. The larger part of this pasture was seeded down in 1924 with a mixture of sweet clover and brome grass. The field has not been very closely pastured and as a result some clover seed has ripened each year and re-seeding has taken place. Although quite a number of cattle have been carried on this pasture there have been no reports of bloating occurring. This may be due to the mixture of grass with the clover, permitting the clover to dry off more quickly after rains or dews and it is quite likely that the mixture of grass and sweet clover has not the same tendency to produce bloating as has the more succulent sweet clover when alone.

Part of the Brandon Experimental Farm herd on sweet clover and grass pasture.

As a hog pasture, sweet clover has gained a certain distinction. It is often possible to turn the hogs on during the latter part of the seeding-down year, or as soon as the plants are 8 or 9 inches high, and whether a nurse crop is used or not, considerable feed should be available. Close pasturing late in the fall is not desirable, for it is preferable to leave some growth for winter protection.

Sweet clover is able to withstand the effects of pasturing somewhat better than alfalfa, and for this reason, and also because of its rapid recovery, it is possible to utilize the first year's crop to a limited extent.

Silage

Many growers have experienced difficulty in curing sweet clover hay in wet seasons. Frequently the hay has to be left on the field for some weeks before it is dry enough to stack with the result that the quality of the hay deteriorates to some extent. Another disadvantage is that ploughing the sweet clover stubble is delayed, waiting for the removal of the hay, and this is very likely to cause a decrease in the yields from the succeeding grain crop.

It was recognized that if the sweet clover could be made into ensilage the anxiety connected with curing the sweet clover hay would be avoided and the land could be ploughed at the proper season. During each of two years eighty tons of sweet clover have been made into silage on the Brandon Experimental Farm. During both the winters of 1927 and 1928 the sweet clover silage was fed to cattle of different ages and tests were made to compare the ensilage made from sweet clover with ensilage made from corn for feeding milch cows. During the first winter the ration for eleven two-year-old heifers consisted of cut straw, mixed with the silage. The animals thrived fairly well on this ration but after a considerable length of time three of the heifers sickened and two of them died. These animals showed typical symptoms of sweet clover poisoning. The silage was discontinued for a few weeks and feeding was again resumed with no apparent ill effects. In ensiling the 1928 crop it was decided to cut the sweet clover at a much earlier stage than had been done in 1927. Wet weather again interfered, consequently the crop was about half in flower at the time of ensiling. The precautions taken to prevent a recurrence of the poisoning in addition to cutting the crop earlier consisted of using freshly sharpened knives on the ensilage cutter so as to cut the sheaves into short pieces. Every effort was made to pack the silage well and as the sweet clover was more mature than seemed desirable, water was added. This silage was fed to both young cattle and mature stock with no apparent injurious effects.

Sweet clover and corn ensilage were compared during both winters as a feed for milch cows. Chemical tests were made by Dr. Shutt, the Dominion Chemist, Central Experimental Farm, Ottawa. His report on the analysis is as follows:—

ANALYSES OF SWEET CLOVER AND CORN SILAGE

Items	Laboratory No. 92698, sweet clover silage	Laboratory No. 92699, corn silage
	%	%
Water	71·90	72·60
Crude protein	3·75	2·65
Crude fat	0·85	0·67
Carbohydrates	10·76	16·53
Fibre	11·04	5·81
Ash	1·70	1·74
	100·00	100·00
Acidity	1·65	2·53

It will be noted that the sweet clover is higher in protein but is considerably lower in carbohydrates. The percentage of fibre in the clover is almost double the amount in the corn.

Harvesting sweet clover for silage.

The results of the two years' feeding trials show sweet clover silage to be about equal to corn in keeping up the body weights of the animals. From the standpoint of milk production the cows on the corn silage gave on an average from one to two pounds more milk per day. This may have been due in part to the fact that the cows did not take as readily to the clover silage as they did to the ensilage made from corn. Another disadvantage found in the sweet clover silage is the disagreeable odour which made it necessary to feed after milking in order that the milk would not be tainted. A third disadvantage is that there is more wastage around the outside of the silo and on top from the sweet clover silage than there was from the corn.

Sweet clover as a crop for ensiling has certain decided advantages over corn. These may be enumerated as follows:—

1. There is very little expense connected with producing a crop of sweet clover. There is the initial investment for sweet clover seed and the cost of ensiling, whereas with corn in addition to the seed it is necessary to prepare the seed bed, plant the corn, and cultivate throughout the summer.

2. There is practically no hand labour connected with growing a crop of sweet clover. Corn on the other hand usually requires in addition to the regular cultivations some hand hoeing.

3. The sweet clover crop is ensiled during midsummer, usually at a time when farmers are not as busy as they are in September, the time for ensiling corn.

Sweet Clover for Green Manure

Where the sweet clover crop can be fed or marketed profitably it is undoubtedly under most conditions a good farm management practice to make use of the crop and then turn under the stubble, but there are districts with very

limited numbers of livestock where the hay crop can not be profitably marketed. The problem is will it pay to turn under a crop of green sweet clover? Experiments in turning under sweet clover conducted on soils that received a plentiful supply of moisture have resulted in a marked improvement in the yields of succeeding crops. Under dry farming conditions this practice has not always resulted in increased yields. The Superintendent of the Scott Experimental Station in the Annual Report of that Station for 1928 shows that during a period of years sweet clover ploughed under in July gave no increased yield in the following crop of wheat nor in the crop of oats that succeeded the wheat. In the same experiment twelve tons of rotted barnyard manure ploughed under in June increased the yields of the succeeding crops by eight bushels of wheat and six bushels of oats.

The experiments at Brandon Experimental Farm for a four year period show that ploughing under a crop of green sweet clover in the summer-fallow year gives an average increase of 3·5 bushels of wheat per acre in the first crop grown on the summer-fallow. Meteorological records show five inches more precipitation at Brandon than at the Scott Experimental Station.

It has been observed that many farmers delay ploughing under their green sweet clover until it is well advanced. Where moisture is a limiting factor much earlier ploughing of the green crop would not only decrease the amount of moisture required by the crop but the sweet clover at the green succulent stage will be less bulky when turned under and is more likely to decompose quickly. It is also generally recognized that the nitrogen is in a more available form in the young sweet clover plants than in the more mature fibrous tissue of the fully developed crop.

Seed Production

It is well known that this crop is an abundant seed producer, but on account of its aggressiveness and persistency, the production of seed has not received the desired amount of attention.

Fairly good yields of seed are reported, ranging from 3 to 15 bushels per acre. The seeds ripen very unevenly, and it is necessary to cut the crop before all the pods are brown in order to prevent too much loss through shattering. The green, immature seeds can be removed in the cleaning process. Cutting can be satisfactorily done with the grain binder, provided the crop is not too tall and coarse. In threshing, unless a huller is available, it is desirable to leave as many of the hulls on as possible, for this enables a more thorough weed seed separation when cleaning.

Like other clovers, sweet clover seed contains a certain proportion of hard seeds. It is necessary to rupture the seed coats of these before they will become permeable to moisture and capable of germination. There is a special machine on the market for the purpose of scarification. There are also some homemade devices which give satisfaction, provided the quantity of seed to treat is not too great. If the seeds are forced by air pressure against a rough surface such as sandpaper, their seed coats will be scratched sufficiently to allow the absorption of the water necessary for germination.

PLACE IN CROP ROTATIONS

A principle now well established in agricultural practice is that growing one type of crop continuously on the same land has injurious effects. To avoid this it is necessary to alternate crops that have widely different habits of growth. The sweet clover crop appears to be particularly suited to alternating with the grain crops. The latter uses considerable nitrogen while the sweet clover takes nitrogen from the air and in soils deficient in nitrogen, may leave more of this valuable constituent than there was in the soil before the clover crop was grown.

The thick, fleshy sweet clover tap roots penetrate deeply into the soil in search of soluble mineral elements. There is quite a storage of this mineral matter in the roots and the top parts of the plant. After the second year growth ceases, the roots and sweet clover stubble decompose and supply the mineral matter for the use of succeeding crops. Another advantage in favour of sweet clover in the rotation is that the stubble from the hay crop can be ploughed under in midsummer whereas except in the summer-fallow year grain stubble can only be ploughed in the fall or spring. One great advantage of midsummer ploughing is the destruction of weeds before they mature their seed and several weeds with creeping root stocks can be more cheaply controlled by thorough cultivation during the last half of summer than where the fields are kept cultivated from early spring.

It has been found to be a decided advantage to alternate the sweet clover with the grain crops in order to check plant disease and insect pests that attack cereal crops. Sweet clover can be sown with grain crops, consequently the cost of establishing a stand of sweet clover is very small. Because of its short life cycle of two seasons, the sweet clover fits particularly well in a rotation that includes mainly cereal crops.

Crop rotation experiments have been under way on the Experimental Farm, Brandon, for many years. In recent years Illustration Stations have been established in Manitoba and the experimental data obtained from the rotations on the Brandon Farm have been used as a basis in planning rotations for these Illustration Stations. It has been recognized that there are certain local conditions that make it impossible to have a standard rotation that will work well in all districts. Nevertheless, there are certain principles that can be followed in planning rotations:—

First—To include a leguminous crop.
Second—To arrange the rotation so that it will control weeds.
Third—To grow the best paying crops on the best land.

On two Illustration Stations, one at Pipestone and the other at Roblin, the following rotation has been one of those under trial. The sequence is as follows:—

First year—Wheat.
Second year—Coarse grains, seeded down to clover.
Third year—Hay. Break after removal of the hay crop.

On the Pipestone Station this rotation was commenced with a view to increasing the humus and nitrogenous content of the light sandy soil. This rotation has not been established long enough to obtain any definite data at Pipestone. At Roblin the rotation was laid down with a view to controlling weeds. The influence on weed control has been quite noticeable. Three years after commencing work on this Station there were comparatively few wild oats or Canada thistle on this rotation while on adjoining fields where the ordinary system of grain growing was followed these weeds had not decreased in numbers.

At Churchbridge, one of the four Dominion Illustration Stations operated from the Brandon Experimental Farm in Eastern Saskatchewan a four-year rotation has been found very satisfactory. The arrangement is:—

First year—Wheat seeded to sweet clover.
Second year—Clover hay, and break.
Third year—Wheat or coarse grain.
Fourth year—Corn or fallow.

One advantage in this rotation is that in seeding with wheat on summer-fallow there is more certainty of establishing a stand than when seeding with a coarse grain crop in the second year after summer-fallow. This arrangement should insure good cereal crops since they follow summer-fallow or corn in one

instance and clover hay in the other. On several other Illustration Stations a five-year rotation has been developed. This is as follows:—

First year—Summer-fallow.
Second year—Wheat seeded to clover and grass mixture.
Third year—Hay and break.
Fourth year—Wheat.
Fifth year—Coarse grains.

This rotation differs from the preceding in having one more year in grain. It is possible that after either the first or second rotation has been used and the weeds brought under control that this last rotation could be used to good advantage.

INFLUENCE ON COST OF SUCCEEDING CROPS

Experimental work at Brandon indicates fairly conclusively that wheat is more cheaply produced when grown after a hay crop containing sweet clover than is possible in any other way. In most of the rotations on the Experimental Farm sweet clover has been used quite extensively in the seeding down mixtures. Records have been kept of the costs entering into wheat production following certain crops and these data have been compiled covering a three-year period. Where wheat is grown on summer-fallow two-thirds of the cost of the fallow has been added to the usual charges. The remaining one-third of the summer-fallow cost has been charged against the second crop after the fallow. In all other instances the costs cover the expenditures from the removal of the one crop to the completion of harvesting the wheat. The data on cost of producing wheat presented in the following table are for three fields each where wheat was grown on fallow and wheat was grown after grasses and clover and two fields each of the second crop of wheat after summer-fallow and for wheat following corn:—

SUMMARY OF COST OF PRODUCING WHEAT

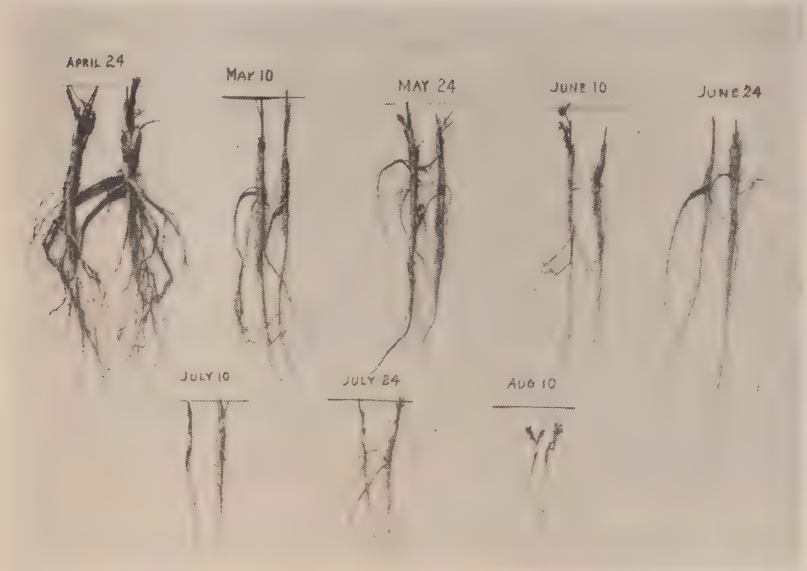
Treatment	Average yields and cost 1927-1929		
	Yield per acre	Cost per acre	Cost per bush
	bush.	$	cts.
Wheat grown on fallow	28·6	23 98	84
Second crop wheat after fallow	21·0	20 51	98
Wheat following corn	16·0	13 07	82
Wheat after grass and sweet clover	25·6	18 83	74

The yield of wheat after grasses and clover is only slightly less than for wheat on summer-fallow. The sod land is cultivated the last half of the summer, consequently the cost per acre is low compared with where the land is summer-fallowed from early spring. The comparatively high yield and low cost per acre affects the cost of production per bushel in a very favourable way. There is 10 cents reduction per bushel as compared with where the wheat was grown on summer-fallow and 24 cents per bushel less than where the wheat was grown on fall-ploughed land.

VARIETIES

There are a large number of so-called sweet clover varieties, many of which are quite indistinct. There are annual and biennial white, as well as annual and biennial yellow-blossoming varieties. At the present time, however, the demand is mainly for the biennial white type, commonly referred to as merely white sweet clover. The main distinguishing characteristics between the common biennial white and yellow sorts are blossom colour and habit of growth.

The biennial yellow is a somewhat smaller-growing earlier-maturing variety, having more tillers, and a finer stem and leaf growth. Yellow blossom sweet clover is not grown as extensively as the white blossom, one reason being that the seed is higher priced. Owing to the more decumbent habit of growth of many of the yellow blossom strains there is more danger of the lower branches being left by the mower or binder and bearing seed. Where two cuttings are taken in one season this frequently happens with the result that there is more danger of the yellow blossom becoming a weed. It seems equally as hardy as the white types.



Roots of sweet clover from successive dates of seeding in 1926 taken up in late April, 1927

Arctic is a white-flowered, biennial variety developed at the University of Saskatchewan. The first seed of this variety planted in Canada had its origin in Northern Siberia. It is generally accepted that Arctic possesses superior hardiness, but since all biennial types of sweet clover tested at this Farm have proven hardy, it is not surprising that no difference has been noted in the winter hardiness of this variety. In maturing, Arctic is probably slightly earlier than the common white. The Arctic is the only variety of sweet clover that can be registered in the Canadian Seed Growers' Association.

The following table gives the yields of the different lots of sweet clover under trial at this Farm during recent years.

SWEET CLOVER VARIETIES

Variety	Source of seed	Average yield per acre cured hay two years	
		tons	lb.
Yellow I.H.C.	International Harvester Co.	2	1,307
Zouave Yellow	University of Saskatchewan	2	952
Common White	McKenzie Seed Co., Brandon	2	672
Common Yellow	McKenzie Seed Co., Brandon	2	604
Arctic White	University of Saskatchewan	2	300

MIXTURES OF SWEET CLOVER AND GRASSES

There are certain conditions that make it advisable to include grasses with sweet clover in seeding down. Where it is planned to leave the field in sod for more than one year it is necessary to include either some of the grasses or alfalfa since the sweet clover dies out at the end of the first hay year.

A second reason for including the grasses is to provide fibre for soils that have a fibre deficiency. Sweet clover by itself with its long tap roots does not furnish nearly as much fibre as do the grasses.

A third reason for mixing grasses and sweet clover is to provide variety when the field is to be pastured. It is also generally believed that there is less danger of stock bloating on a pasture comprised of a mixture of clover and grass than there is where no grass is present. The following table gives the average yields of cured hay from a mixture of clover and grass during a six year period. The rate of seeding was six pounds clover and six of grass in each case. Where two grasses were sown with the clover the rate of seeding was six pounds of clover and three of each of the grasses.

MIXTURES OF GRASSES AND CLOVER

Mixture	Average yield per acre cured hay six years	
	tons	lb.
Sweet clover and western rye	2	1,865
Sweet clover and brome	2	1,745
Sweet clover and meadow fescue	2	796
Sweet clover and western rye and brome	3	117

There appeared to be very little difference in the yields obtained from the mixtures containing western rye grass and brome grass. There was approximately one-half ton of hay less from the plot containing meadow fescue. Where the two grasses were included with the clover there was a slight increase in yield. As further evidence it might be mentioned that a similar increase has been obtained when two grasses instead of one were mixed with alfalfa.

INOCULATION

If neither sweet clover nor alfalfa has been grown on the land before, it will be necessary to inoculate the seed before seeding, in order to supply the young plants with the bacteria which are capable of extracting free nitrogen from the air.

The proper culture for artificial inoculation can be obtained from the Dominion Bacteriologist, Central Experimental Farm, Ottawa, or from the Manitoba Agricultural College. This culture is supplied in small bottles with full directions for its proper use. Satisfactory inoculation can also be accomplished by scattering fine, surface soil from an old alfalfa or sweet clover field over the seed which has been previously treated with some sticky substance such as furniture glue that will cause the soil particles to adhere. This latter method of inoculation has been outlined in Prof. Hanson's bulletin on legume inoculation, which states that by moistening the seed with a five per cent solution of glue, or about one-half pound of the glue to one gallon of water, sufficient soil particles containing the desired organisms will stick to the seed to bring about satisfactory inoculation.

Inoculation can also be brought about by spreading surface soil from an old alfalfa or sweet clover field on to the land to be seeded to sweet clover. This soil should be applied at the rate of from 100 to 200 pounds per acre, and harrowed in directly after application.

Artificial inoculation by pure culture is probably most generally used, and is to be recommended over the other two methods mentioned above.

CULTURAL METHODS

Dates of Seeding

Since moisture is to a large degree the determining factor in crop production in Manitoba, it is ordinarily good practice to seed as early as possible and yet escape spring frost injury. When seeding with a nurse crop, early seeding becomes even more important. Unless the young seedlings of sweet clover get well established before the first drought, they may receive a set-back from which they will not fully recover. When the clover is to be seeded without a nurse crop, early seeding is not so important. When seeded early alone it may be possible to harvest a crop of hay the first season, or secure some fall pasturage.

View of the sweet clover nursery on the Brandon Experimental Farm.

DATES OF SEEDING SWEET CLOVER

Date sown	7-year average cured hay per acre	
	tons	lb.
April 25	2	1,206
May 10	2	1,504
May 25	2	1,569
June 10	2	1,571
June 25	2	773

In this experiment the sweet clover was sown with wheat in each instance and since wheat is generally sown early in the spring it can be assumed that this is a safe practice to follow particularly since wheat is recognized as the most suitable of the spring sown cereals for use as a nurse crop. On the other hand when the sweet clover is to be sown with the coarse grains it would appear to be fairly safe to sow up to the latter part of June, providing there is a plentiful supply of moisture in the soil and the land is reasonably free from weeds.

Rates of Seeding

The data available indicate that the yields of sweet clover are influenced by the rate of seeding. While it is recognized that the number of plants that a given area of soil can support is limited, it is also known that there is frequently a heavy loss of plants during the seedling stage. It is also believed that the quality of the crop is improved by thick seeding. The experiments on the Brandon Experimental Farm in rates of seeding have been conducted on fairly rich soil in good tilth consequently it will be expected that the minimum amount

Left—Seeded at the rate of 6 pounds per acre. Right—25 pounds per acre.

of seed would be all that would be required to obtain a full stand, particularly since good, clean, scarified seed is used. The results of the experiment, however, go to show that there has been a gradual increase in the hay crop as the rate of seeding was increased, ample in all cases except one to pay for the extra amount of seed used. The difference in yield between the 20 and 25 pound rate of seeding would not pay for the extra five pounds of seed. It is also interesting to note that in four years out of the five this increased yield from the heavier rates of seeding was obtained, but in one year there was very little difference in the yields from the different rates of seeding.

RATES OF SEEDING SWEET CLOVER

Rates sown	5-year average cured hay per acre	
	tons	lb.
6 pounds per acre	2	1,500
9 " "	2	1,580
12 " "	2	1,813
15 " "	2	1,983
20 " "	3	116
25 " "	3	171

Nurse Crops

In discussing the kinds of nurse crops for sweet clover, the experimental results obtained are significant. Four different nurse crops have ben tested with sweet clover, in an effort to determine which combination gives the most desirable returns. A standard rate of 10 pounds per acre has been used in seeding the clover, while with the exception of flax, less than the normal rate of seeding has been used with the nurse crops. The results of the experiment to-date are here tabulated:—

NURSE CROPS

Kind of nurse crop	Rate of seeding nurse crop	Average yield per acre for 4 years, cured hay 2nd season	
	pecks	tons	lb.
Sweet clover sown alone		3	655
" " with flax	2	3	494
" " " wheat	5	3	61
" " " barley	6	2	1,522
" " " oats	8	2	1,480

Sweet clover can be produced more economically when a nurse crop is used than when grown alone. It must be remembered, however, that this test was conducted on comparatively heavy clay loam, fairly retentive to moisture, and consequently the competitive action brought about by the use of a nurse crop is not so evident as would be the case on poorer soils.

It is also shown that the increased yield of clover the second year, grown without a nurse crop, is insignificant. When comparing the yields of clover following the different nurse crops, it appears that flax has the least detrimental effect on the second year crop. Flax, however, does not make a desirable nurse

crop for sweet clover, because it produces so little shade that the clover is not retarded in its growth, usually reaching a height that makes the handling of the flax difficult, and producing a coarser crop the following year. In this respect the sweet clover yield is very much the same as when the crop is seeded alone. The results indicate that any of the common cereals make desirable nurse crops, and the choice will be governed by the requirements. Wheat is possibly more dependable because of its strength of straw and the fact that its leaves shrivel earlier in the season, allowing more light to reach the young clover plants. There is, however, sufficient shade produced by the wheat plants to prevent any excessive growth of the clover the first year, thus making the nurse crop easy to harvest.

The use of a nurse crop is also beneficial from the standpoint of winter protection. The stubble tends to hold the snow, and the results at this Farm show little or no winter-killing on the stubble plots, while approximately 5 per cent of the stand was killed on the plots sown alone. It has been observed that the coarsest and least palatable hay is harvested from the plots sown without a nurse crop. This is probably due to the rank growth of the crop during the first year. The percentage of leaf on the clover crop grown with wheat, oats, and barley averaged 34·4 per cent, while the plots sown alone averaged 31·2 per cent. While these figures do not show any marked difference, yet they indicate that the quality of hay is lowered when sweet clover is seeded without a nurse crop.

Rates of Seeding Wheat as a Nurse Crop

When wheat is used as a nurse crop for sweet clover the growth of the clover the first year as well as the stand will be affected in no small degree by the rate of seeding the wheat. While there may be a slight decrease in yield in wheat if the rate of seeding is much reduced, it would seem natural to expect that the clover would make the more favourable response with the lesser competition offered by a thinly seeded nurse crop.

In the following experiment the clover was seeded at the rate of ten pounds per acre.

RATES OF NURSE CROP SEEDING

Rate of seeding nurse crop per acre	Average yield of cured hay per acre, 4 years	
	tons	lb.
Wheat—		
3 pecks	3	427
5 "	3	331
7 "	3	155
9 "	2	391

When a nurse crop is used the two crops compete for moisture and nutrients in the soil. Because of the quicker germination and growth the grain crop becomes established sooner than the sweet clover. This gives the nurse crop a decided advantage. When the amount of moisture is limited the sweet clover seedlings are the first to suffer. Light is essential to the normal growth of the sweet clover. If the nurse crop is a thick stand and leafy, the amount of light reaching the sweet clover is inadequate for its proper development and the stand of clover may be materially reduced. If the nurse crop is harvested early and there is a plentiful supply of autumn rain the clover crop may recover, but if conditions are unfavourable during the autumn there may be a heavy loss

from winter-killing. This experiment would indicate that under conditions similar to those at Brandon it is reasonably safe to sow at the rate of $1\frac{3}{4}$ bushels of wheat per acre. The soil on which these experiments have been conducted is fairly heavy and there has been a sufficient supply of moisture as the seeding down has usually been done on summer-fallow land. Where seeding down is practised with the second or third crop after summer-fallow it would be advisable to reduce the rate of seeding the nurse crop to approximately one bushel per acre.

HARVESTING

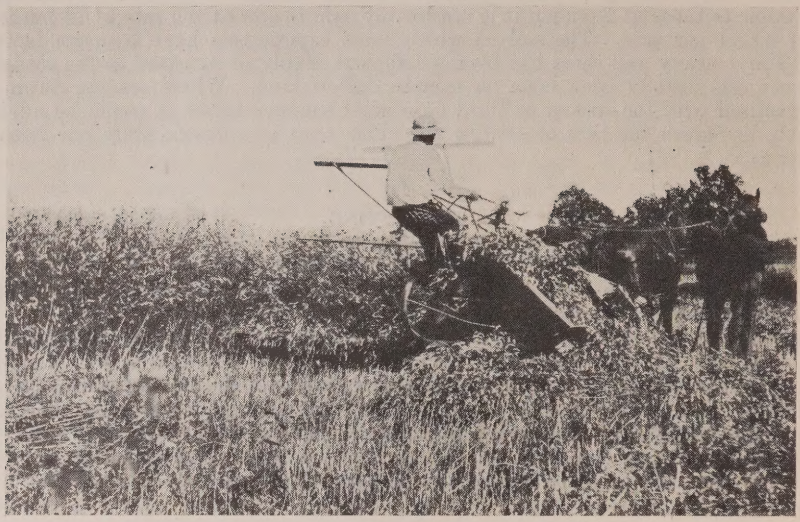
Method of Cutting

Harvesting sweet clover for hay with the binder has proven satisfactory on this Farm. As the leaves constitute the most desirable part of the hay, it is important that as many of these be preserved as possible. When cutting with the mower, the crop has to be left in the swath for several days in order to partially dry out the coarse stems. During this period the leaves become so dry and brittle that only a small proportion are retained by the time the crop is cured. When the tedder is used, better results may be obtained, provided there is good weather. In wet weather, curing in the swath is practically impossible. The high moisture content of the stems, and the slowness of drying out, make conditions excellent for the growth of moulds. Sweet clover hay, spoiled in this way, has been reported as having caused cattle poisoning in certain parts of Minnesota, North Dakota, and Ontario.

When cutting sweet clover with the binder it is well to tie the sheaves rather loosely and make them small. This allows for more rapid drying out and lessens the possibility of mould development in case of wet weather. If long narrow stooks are made, they will cure in about fifteen or twenty days of good weather. A much larger proportion of leaves is saved by binding the crop, as only the outside and top of the sheaves are subjected to much shattering. Since dry weather cannot be depended upon during the period of harvesting the first crop, the binder method seems most satisfactory. Stacking in the ordinary way as with grain, where storage is not available, is a good practice. It is well to cover the top of the stack with hay, for the reason that sweet clover, like other legumes, does not shed water readily.

Time to Cut

It has generally been recommended that sweet clover should be cut for hay just before it commences to bloom. Chemical analysis have shown that there is an increase in fibre and a decrease in protein and carbohydrates during the early flowering period. Where two cuttings of sweet clover are to be taken it will usually be found advisable to take the first crop early in order to give the second growth a better opportunity to get started. In recent years in districts where there is a fair supply of moisture the practice has developed of only taking one cutting and then ploughing the land after the removal of the crop and making a part-year summer-fallow. Investigations conducted at Brandon during a three-year period have shown that there is a rapid growth and a marked increase in tonnage between the time the sweet clover is well advanced in the bud stage and when it is 35 per cent in flower. In this experiment the sweet clover was cut in one instance to leave a four-inch stubble and on another set of plots the crop was cut to leave a seven-inch stubble.



Harvesting sweet clover with a binder.

THE STAGE OF GROWTH TO CUT SWEET CLOVER

—	Bud Stage			75% terminal buds formed			35% in flower		
	Date cut	tons	lb.	Date cut	tons	lb.	Date cut	tons	lb.
Height of stubble	4 inches								
1927	June 23	2	844	July 4	2	1,356	July 15	4	1,602
1926	June 25	0	1,388	June 29	1	531	July 2	1	576
1925	June 25	1	1,518	June 29	1	1,431	July 10	3	1,945
Average	June 24	1	1,250	June 30	1	1,772	July 9	3	710
	Date cut	tons	lb.	Date cut	tons	lb.	Date cut	tons	lb.
Height of stubble	7 inches								
1927	June 23	2	289	July 4	2	1,378	July 15	4	1,513
1926	June 25	0	1,206	June 29	1	37	July 2	1	581
1925	June 25	1	965	June 29	2	158	July 10	2	1,940
Average	June 24	1	820	June 30	1	1,190	July 9	3	11

The most interesting feature brought out by this experiment is the rapid increase in total tonnage between the average date of June 30 and July 9. In the one instance where the stubble was left four inches high this amounts to 1 ton 939 pounds per acre and on the other set of plots 1 ton 821 pounds. There will undoubtedly be some loss in palatability since it appears to be generally accepted that the coumarin content increases during the flowering stage, also there is a noticeable increase in fibre while the percentage of protein and carbohydrates decreases as the sweet clover advances in the flowering stage. Nevertheless, this rapid growth will more than counterbalance the loss in percentage of these constituents.

Another advantage in delaying cutting until the plants are about one-third in flower is that then the plants will undoubtedly contain a lower percentage of moisture and the branches keep the sheaves more open than when the crop is cut at an earlier stage, consequently the crop cures more quickly.

The difference between leaving the stubble four inches and seven inches high might be taken to represent the difference between a clover crop cut fairly high with a mower and fairly low with a grain binder. This experiment would indicate that the loss of 570 pounds of cured hay might be expected from leaving a seven-inch stubble, but since this would be mainly comprised of the coarsest part of the stalks this loss would not be sufficient in most years to make up for the extra labour required in harvesting sweet clover in the same way the grasses are handled.

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